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Tekulve et al.

(54) VENOUS CLOT BASKET

(71) Applicant: **COOK MEDICAL TECHNOLOGIES LLC**, BLOOMINGTON, IN (US)

(72) Inventors: **Kurt J. Tekulve**, Ellettsville, IN (US); **Frank J. Fischer, JR.**, Bloomington, IN (US)

(73) Assignee: **COOK MEDICAL TECHNOLOGIES LLC**, BLOOMINGTON, IN (US)

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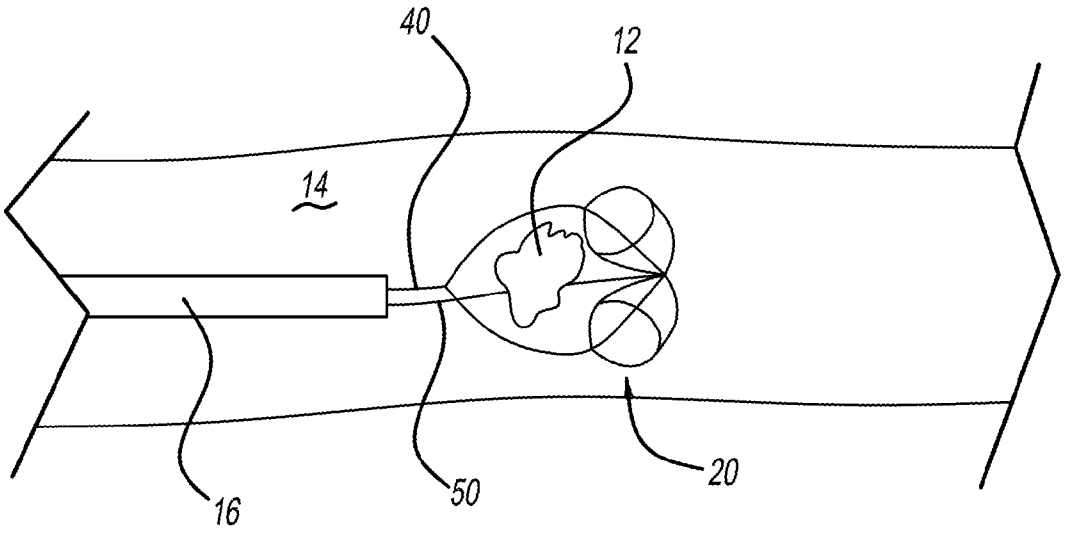
(57) **ABSTRACT**

A system for removing a blood clot from a blood vessel or vein is provided. The system includes a plurality of support members that can be expanded to define a basket. The support members include a mesh portion at their distal ends. The system includes a first wire attached to the proximal end of the basket defined by the support members and a second wire attached to a distal end of the basket. The second wire extends through the middle of the basket when the basket is in the expanded condition. The width of the basket can be adjusted by adjusting the second wire relative to the first wire, and the location of the basket can be adjusted by adjusting the first wire. The basket is delivered distally beyond the blood clot, where it is expanded outward. The blood clot is captured by translating the basket proximally.



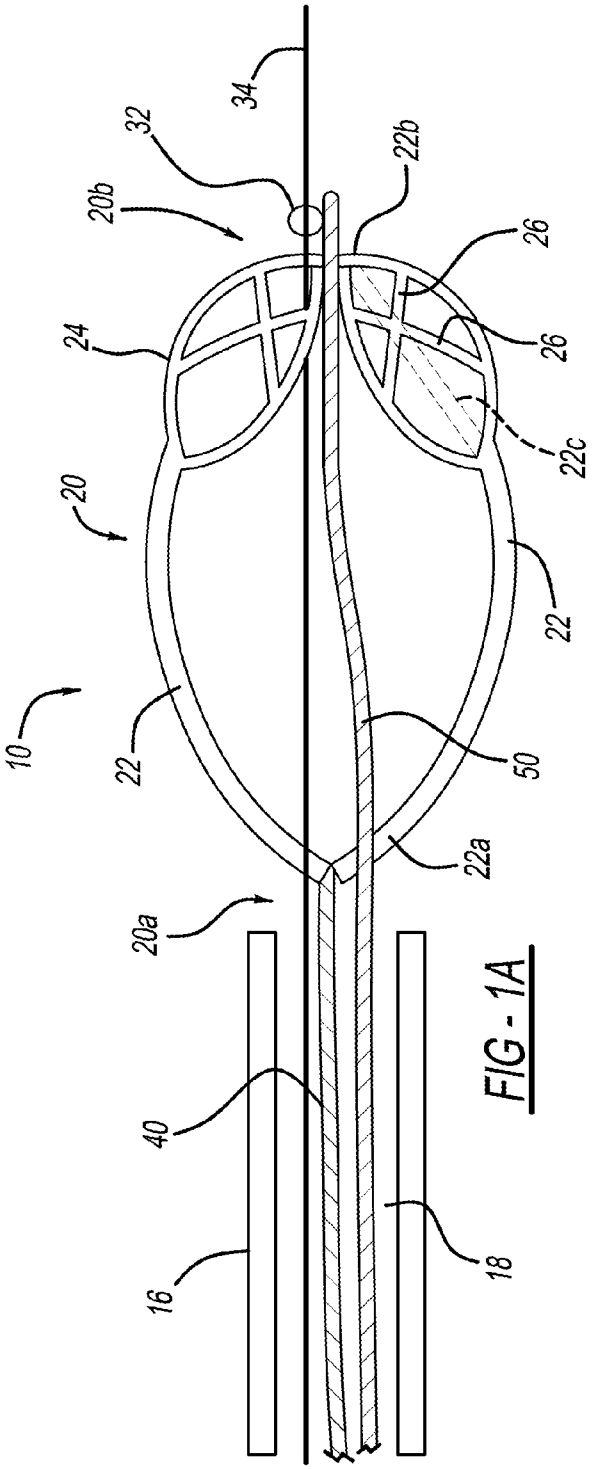


FIG - 1A

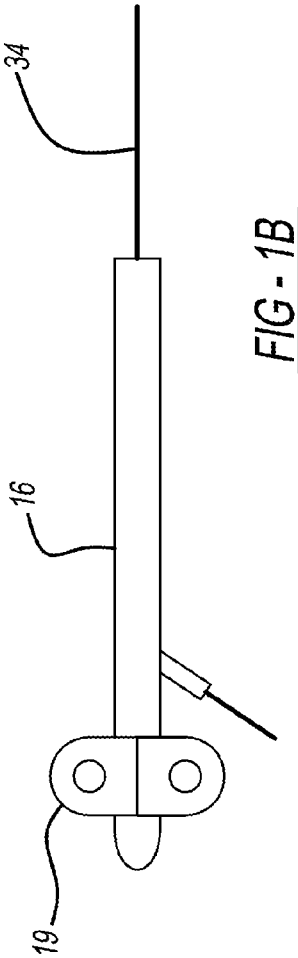


FIG - 1B

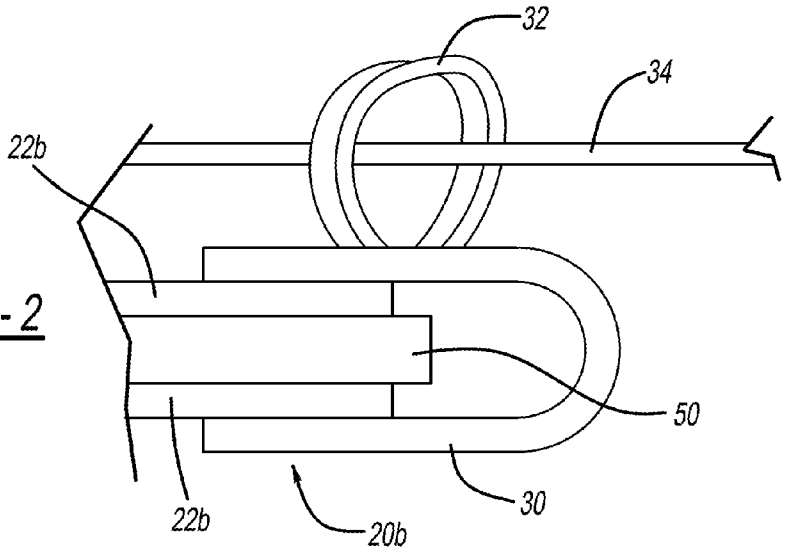


FIG - 2

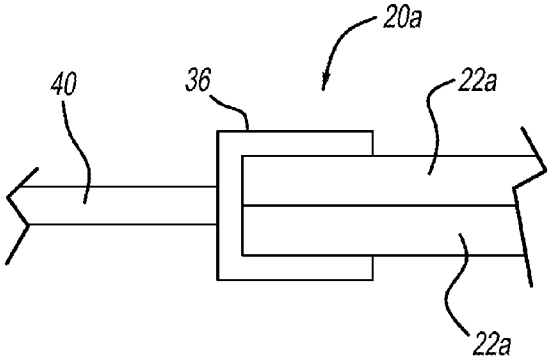


FIG - 3

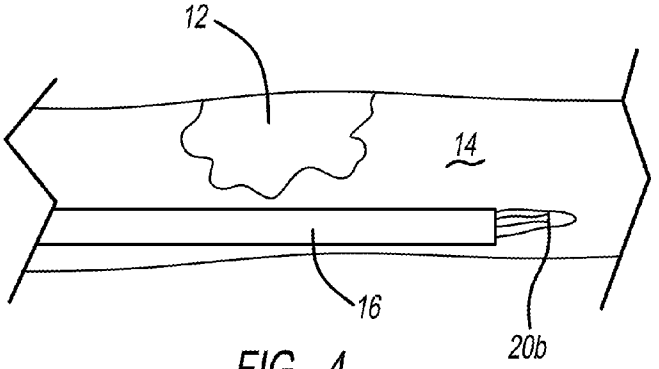


FIG - 4

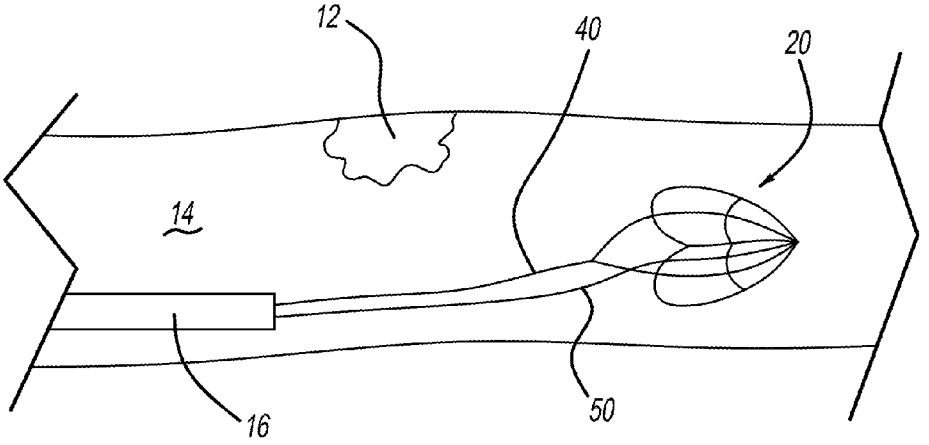


FIG - 5

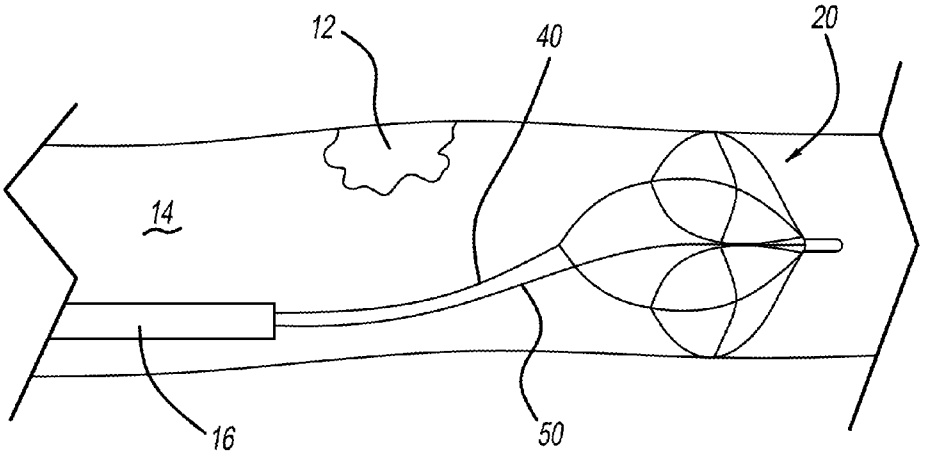


FIG - 6

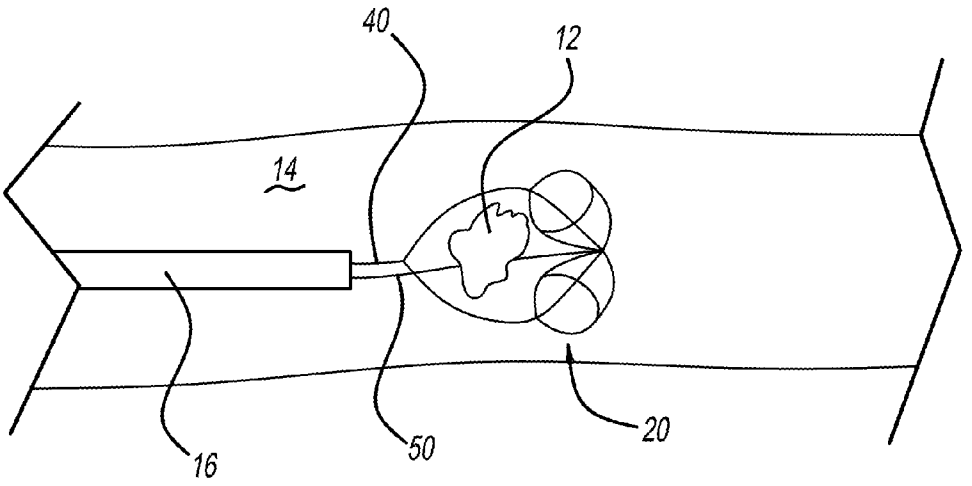


FIG - 7

VENOUS CLOT BASKET

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 61/746,321 filed Dec. 27, 2012, the content of which is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] The present embodiments relate generally to a system, apparatus, and method for closing removing a clot from the venous system and, more particularly, for an expandable and adjustable basket for removing a blood clot from the blood vessel.

[0003] A venous system includes myriad blood vessels for transferred and circulating blood throughout the human body. Blood clots can form throughout the venous system over time, which can result in a dangerous condition for the patient depending on the size and/or location of the clot. The blood clots that form inside a blood vessel can be referred to as a thrombosis.

[0004] One type of thrombosis is known as Deep Vein Thrombosis or Deep Venous Thrombosis and is commonly abbreviated as "DVT." DVT is the formation of a blood clot in a deep vein, as can commonly occur in the veins within a patient's legs. DVT can result in substantial discomfort to patient, as well as affecting the external appearance of the patient's legs. As such, DVT can result in pain, swelling, redness, or engorged superficial veins. Additionally, DVT can lead to a potentially life threatening condition, known as a pulmonary embolism, where a blood clot can detach from a vein and travel to the lungs. Thus, it is desirable to limit the occurrence of DVT or remove the clots from the veins.

[0005] Thus, there is a need for a device that can effectively and reliably remove a blood clot from a patient's blood vessel.

SUMMARY

[0006] A system for removing a blood clot from a blood vessel is provided, the system comprising: a tube member having a proximal end and a distal end, the tube member having a lumen formed through the proximal and distal ends, the lumen defining a longitudinal axis therealong; a first support member having a proximal end and a distal end, the first support member having a first mesh portion at the distal end thereof; a second support member having a proximal end and a distal end, the second support member having a second mesh portion at the distal end thereof; a first wire extending through the lumen, the first wire being attached to the proximal ends of the first and second support members; a second wire extending through the lumen, the second wire being attached to the distal ends of the first and second support members; wherein the first and second support members define a basket therebetween when the first and second support members are expanded from the second wire; wherein the second wire is configured for adjusting the basket between an expanded state and a compressed state; wherein the first wire is configured for adjusting the longitudinal location of the basket; and wherein the second wire extends within the basket defined by the expanded first and second support members when the basket is in the expanded state.

[0007] In another form, the longitudinal location of the basket is adjusted proximally by pulling on the first wire relative to the tube member.

[0008] In another form, the support members are made from a shape memory material.

[0009] In another form, the support members are configured to expand into the expanded condition based on the shape memory material.

[0010] In another form, the support members are configured to expand into a further expanded condition by pulling on the second wire relative to the first wire.

[0011] In another form, the expanded condition of the basket is maintained by pulling on both the first wire and the second wire.

[0012] In another form, the expanded condition of the basket is narrowed by pulling on the first wire relative to the second wire.

[0013] In yet another form, a method for removing a blood clot from a blood vessel is provided, the method comprising the steps of: inserting a tube member having a first support member and a second support member disposed therein to a location of a blood clot within a blood vessel, wherein the support members have proximal and distal ends thereof, a first wire is attached to the proximal end of the support members, and a second wire is attached to the distal end of the support members; extending the support members out of the tube member, wherein the distal ends of the support members are exposed; locating the distal ends of the support members distally from a blood clot; expanding the support members outwardly from the second wire to form a basket having proximal and distal ends thereof, wherein at least a portion of the second wire is disposed within the basket and radially between the support members; and withdrawing the basket proximally to remove the blood clot.

[0014] In another form, the support members are made from a shape memory material, and the shape memory material expands the support members to form the basket.

[0015] In another form, the support members include a mesh portion at distal ends thereof, and the mesh portions form the basket in response to expanding the support members.

[0016] In another form, the method further comprises additionally expanding the support members to contact the vessel wall.

[0017] In another form, the method further comprises moving the second wire proximally relative to the first wire to expand the support members.

[0018] In another form, the method further comprises moving the first wire proximally to pull the proximal end of the basket toward the tube member.

[0019] In another form, the method further comprises moving the first wire and second wire together to maintain the shape of the basket member and adjust the longitudinal location of the basket.

[0020] In yet another form, a blood clot retrieval apparatus is provided comprising: a first support member having a proximal end and a distal end, the first arm member having a first mesh portion at the distal end thereof; a second support member having a proximal end and a distal end, the second arm member having a second mesh portion at the distal end thereof; a first wire extending proximally and attached to the proximal ends of the first and second support members; a second wire extending proximally and attached to the distal ends of the first and second support members; wherein the

first and second support members are configured to adjust between a compressed condition and an expanded condition; wherein the expanded condition defines a basket; wherein the second wire extends within the basket; and wherein the second wire is configured for adjusting the width of the basket.

[0021] In another form, the distal ends of first and second support members are mounted within a distal housing.

[0022] In another form, the apparatus further comprises a wire guide coil attached at the distal ends of the first and second support members.

[0023] In another form, the first and second wire are adjustable relative to each other to change the shape of the basket defined by the first and second support members.

[0024] In another form, the first and second wire are adjustable together to maintain the shape of the basket defined by the first and second support members while translating the basket.

[0025] In another form, the support members are made from a material having shape memory characteristics that define a shape of the basket absent actuation by the first or second wires.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] FIG. **1**A is a schematic view of a system for removing a clot from a blood vessel;

[0027] FIG. **1**B is a schematic view of the system showing a handle;

[0028] FIG. **2** is a side view of a distal end of a basket defined by support members;

[0029] FIG. **3** is a side view of a proximal end of the basket;

[0030] FIG. **4** is a schematic view of the system showing the basket being delivered distally beyond a blood clot;

[0031] FIG. **5** is a schematic view of the basket in an expanded condition;

[0032] FIG. **6** is a schematic view of the basket in another expanded condition; and

[0033] FIG. **7** is a schematic view of the basket having the blood clot captured therein.

DETAILED DESCRIPTION

[0034] Referring now to the drawings, FIGS. **1**A-**7** illustrate a system **10** for removing a blood clot **12** from a blood vessel **14**. The system **10** includes a tube member or catheter **16** having a generally tubular shape and a lumen **18** extending therealong. A handle **19** can be attached to the proximal end of the catheter **16** for controlling the system. The system further includes a collapsible basket **20** that is configured to transfer from a compressed condition into an expanded condition. The basket **20** can be housed within the catheter **16** for delivery to the location of the blood clot **12**, as further described below.

[0035] With reference to FIG. **1**A, the basket **20** includes a plurality of support members **22** extending from a proximal end **20***a* of the basket **20** to the distal end **20***b* of the basket **20**. In one form, the basket **20** includes two support members **22**; however, other quantities of support members **22** can also be used, such as a basket formed from four support members **22**. For purposes of discussion, a pair of support members **22** will be described. Each support member **22** has a generally elongate shape with a proximal end **22***a* and a distal end **22***b*. The support members **22** can be made from a material having shape memory characteristics, such as Nitinol, such that the support members **22** will tend to spring outward from a compressed condition to expand the basket **20**. Alternatively, the shape memory characteristics could be tuned to another shape, such as the compressed condition, if desired.

[0036] Each support member **22** also includes a mesh portion **24** that is disposed at the distal end thereof. The mesh portion **24** can be formed from a plurality of interconnected struts **26** that are collectively mounted to the support member **22**. The mesh portion **24** can be made from the same material as the support member **22**, such that the mesh portion **24** is integrally formed with the support member **22**. Alternatively, the struts **26** of the mesh portion **24** can be attached as separate pieces of the support member **22**.

[0037] The size of the mesh portion **224** can vary depending on the needs of the user and size of the blood vessel **14**. Additionally, the space between the struts **26** can be varied by adding or subtracting struts **26** to the mesh portion **24** to accommodate various blood clot **12** sizes. Thus, it will be appreciated that the mesh portion **24** is scalable in this regard depending on the needs of the user.

[0038] In one form, the support member **22** can include a main support strut **22***c* (shown in broken line in FIG. **1**A) that extends from the proximal end **20***a* to the distal end **20***b* of the basket **20**, with the struts **26** of the mesh **24** extending from the main support strut **22***c*. In another form, the struts **26** can form the mesh **24**, with the length of the support member **22** being interrupted by the mesh **24**, such that the support member **22** is effectively broken up, with the distal end **22***b* defined by the mesh **24**, and the proximal end **22***a* of the support member **22** extending proximally from the mesh **24**. The mesh **24** can be made from Nitinol or another material having shape memory characteristics, such that mesh **24** will open outwardly upon being released from a compressed condition.

[0039] With reference to FIG. **2**, the distal ends **22***b* of the support members **22** can be mounted together at the distal end **20***b* of the basket **20**. The support members **22** can be mounted together via a distal tip housing **30** that encompasses the distal ends **22***b* of the support members **22**. The distal tip housing **30** can further include a wire guide coil **32** in the form of a loop extending therefrom. However, in another form, the wire guide coil could be formed by one or more of the support members **22**. The wire guide coil **32** is configured for allowing a guidewire **34** to be inserted therethrough for assisting in locating the basket **20** along the venous system.

[0040] With reference to FIG. **3**, the proximal ends **22***a* of the support members **22** can be mounted together at the proximal end **20***a* of the basket **20** as well. In one form a proximal tip housing **36** can encompass the proximal ends of the support members **22** **22** similar to the distal tip housing **30** described above. In another form, the proximal ends **22***a* can be fused together in a manner known in the art. In another form, the proximal ends **22***a* can be banded together. In another form, the proximal ends **22***a* can be wound or braided together. Of course, other manners of joining the proximal ends **22***a* of the support members **22** at the proximal end **20***a* of the basket **20** can also be used.

[0041] The system **10** further includes a first wire **40** member mounted to the proximal end **20***a* of the basket **20**. The first wire **40** can generally extend through the lumen **18** to the handle **19** so that the wire can be actuated and adjusted by the user at the handle **19**. The first wire **40** is configured for adjusting the longitudinal position of the basket **20**. More specifically, the first wire **40** is configured to be pulled for translating the basket **20** back toward the tube or catheter **16** after the basket **20** has been deployed. The distal end of the

first wire **40** can be mounted or attached to the proximal ends **22***a* of the support members **22** via known methods. In one form, the first wire **40** can be in the form of the support members **22** wound or braided together to form the first wire **40**.

[0042] With reference again to FIG. **2**, in addition to the first wire **40**, the system **10** includes a second wire **50** that is mounted to the distal ends of the support members **22** and the basket **20**. The second wire **50**, like the first wire **40**, extends through the lumen **18** and is attached or mounted to the handle **19** so that it can be actuated or adjusted by the user at the handle **19**. The second wire **50**, unlike the first wire **40**, extends along the length of the support members **22** due to its mounting at the distal ends **22***b* thereof. The second wire **50** will extend within the support members **22** when the support members **22** are expanded outward to define the expanded basket **20** when the basket **20** has been deployed from the tube or catheter **16**. The second wire **50** is configured to adjust the expanded shape of the basket **20** defined by the support members **22** and mesh portions **24**. More specifically, the second wire **50** can be pulled to move the distal end **20***b* of the basket **20** to cause the basket **20** to compress longitudinally, thereby causing it to expand radially. The second wire **50**, being attached to the distal ends of the support members **22** and the basket **20**, can be mounted within the distal tip housing **30** along with the distal ends of the support members **22**. However, the second wire **50** could also be mounted outside the housing **30** or otherwise near the distal ends of the support members **22** and basket **20**.

[0043] The first wire **40** and the second wire **50** are preferably adjustable independent of each other to control the shape and location of the basket **20**. In one form, the wires **40** and **50** can have a generally rigid form to allow the wires **40** and **50** to be both pulled and pushed from the handle **19** to adjust the longitudinal location of either the proximal end of the basket **20** or the distal end of the basket **20**, or both. Pulling on the first wire **40** relative to the second wire **50** will cause the basket **20** to become longer and narrower. Pulling on the second wire **50** relative to the first wire **40** will cause the basket **20** to become shorter and wider. Pulling on both wires **40** and **50** will cause the basket **20** shape to remain relatively constant while pulling the basket **20** proximally. It will be appreciated that the wires **40** and **50** can likewise be pushed relative to each other, or together, to effect similar changes in the basket **20** shape and location.

[0044] The system further includes the guidewire **34**, mentioned above with respect to the wire guide coil. The guidewire **34** can extend through the lumen **18** of the catheter **16** along with the first and second wires **40** and **50**. Similar to the second wire **50**, the guidewire **34** will extend along the length of the basket **20** and can extend within the basket **20** when the basket **20** is expanded. The guidewire **34** allows the catheter **16** and the basket **20** housed therein to be delivered to the area of the blood clot **12** within the blood vessel **14**.

[0045] Having described the structure of the system **10** above, the function and use of the system **10** will now be described.

[0046] To remove a blood clot **12** from within a blood vessel **14**, the surgeon can identify the location of the blood clot **12** according to known medical methods. The tube or catheter **16**, having the support members **22** that form the basket **20** contained within the lumen **18** in a compressed condition, can be inserted into the blood vessel **14** via a percutaneous procedure or other minimally invasive method known in the art.

[0047] With reference to FIG. **4**, the tube or catheter **16** can be guided along the guidewire **34** to the location of the blood clot **12** within the vessel **14**. Once at the location of the blood clot **12**, the catheter **16** can be inserted past the blood clot **12**, where the catheter **16** can then be retracted to expose the support members **22** forming the basket **20** in the compressed condition. Alternatively, the basket **20** can be pushed out from the catheter **16**, with the catheter **16** remaining stationary to expose the support members **22** forming the compressed basket **20**.

[0048] With reference to FIG. **5**, once the support members **22** are exposed, the shape memory characteristics of the support members **22** will cause the support members **22** to expand outwardly to form the expanded basket **20**. More specifically, the mesh portion **24***s* of the support members **22** will expand outwardly as well. The expanded condition caused by the shape memory characteristics of the support members **22** can be an intermediate expanded condition, where the basket **20** does not fully expand to span the width of the blood vessel **14**, depending on the size of the basket **20** determined by the shape memory characteristics relative to the size of the blood vessel **14**.

[0049] With the basket **20** in this intermediate condition, the second wire **50** can be adjusted proximally, or pulled, to cause the distal end of the basket **20** to translate proximally relative to the proximal end of the basket **20**. This relative translation will cause the basket **20** to expand into a fully expanded condition that extends across substantially the entire width of the blood vessel **14**, as shown in FIG. **6**. It will be appreciated that the reference to the fully expanded condition does not necessarily mean the maximum amount of radial expansion, but rather the desired expanded width of the basket **20** as determined by the user.

[0050] With reference to FIG. **7**, with the basket **20** in the desired expanded condition, the first and second wire **50** can be pulled proximally to translate the basket **20** proximally and along the blood vessel **14** toward the clot **12**. The basket **20** can then capture the blood clot **12** or embolism (or multiple clots **12** or emboli) as the basket **20** translates.

[0051] The basket **20** can be further translated proximally toward the catheter **16**, delivering the blood clot **12** or embolism toward the catheter **16** as well. Once the blood clot **12** has been delivered to the catheter **16**, the clot **12** can be aspirated out through the catheter **16**. In another form, the entire system **10** can be pulled back with the clot **12** captured by the basket **20** to remove the blood clot **12** as the catheter **16** and basket **20** are removed from the blood vessel **14**.

[0052] Alternatively, or in addition to the above described method, the blood clot **12** can be broken up or compressed by the basket **20**. As previously described, the shape of the basket **20** can be adjusted by adjusting the first and second wire **50***s* relative to each other. With the blood clot **12** captured within the basket **20**, the basket **20** can be compressed by moving the first wire **40** proximally relative to the second wire **50** to extend the length of the basket **20** and narrow the width of the basket **20**, thereby applying a compressive force to the clot **12** to break up or compress the clot **12** to assist in aspirating the clot **12** through the catheter **16**.

[0053] At the conclusion of the clot **12** retrieval, the system **10** can be removed from the blood vessel **14**, completing this aspect of the medical procedure. The surgeon can subse-

quently perform additional procedures or complete the surgical intervention in a manner known in the art.

[0054] As a person skilled in the art will readily appreciate, the above description is meant as an illustration of implementation of the principles this invention. This description is not intended to limit the scope or application of this invention in that the invention is susceptible to modification, variation, and change, without departing from the spirit of this invention, as defined in the following claims.

What is claimed is:

1. A system for removing a blood clot from a blood vessel, the system comprising:

a tube member having a proximal end and a distal end, the tube member having a lumen formed through the proximal and distal ends, the lumen defining a longitudinal axis therealong;

a first support member having a proximal end and a distal end, the first support member having a first mesh portion at the distal end thereof;

a second support member having a proximal end and a distal end, the second support member having a second mesh portion at the distal end thereof;

a first wire extending through the lumen, the first wire being attached to the proximal ends of the first and second support members;

a second wire extending through the lumen, the second wire being attached to the distal ends of the first and second support members;

wherein the first and second support members define a basket therebetween when the first and second support members are expanded from the second wire;

wherein the second wire is configured for adjusting the basket between an expanded state and a compressed state;

wherein the first wire is configured for adjusting the longitudinal location of the basket; and

wherein the second wire extends within the basket defined by the expanded first and second support members when the basket is in the expanded state.

2. The apparatus of claim **1**, wherein the longitudinal location of the basket is adjusted proximally by pulling on the first wire relative to the tube member.

3. The apparatus of claim **1**, wherein the support members are made from a shape memory material.

4. The apparatus of claim **3**, wherein the support members are configured to expand into the expanded condition based on the shape memory material.

5. The apparatus of claim **4**, wherein the support members are configured to expand into a further expanded condition by pulling on the second wire relative to the first wire.

6. The apparatus of claim **1**, wherein the expanded condition of the basket is maintained by pulling on both the first wire and the second wire.

7. The apparatus of claim **1**, wherein the expanded condition of the basket is narrowed by pulling on the first wire relative to the second wire.

8. A method for removing a blood clot from a blood vessel, the method comprising the steps of:

inserting a tube member having a first support member and a second support member disposed therein to a location of a blood clot within a blood vessel, wherein the support members have proximal and distal ends thereof, a first wire is attached to the proximal end of the support members, and a second wire is attached to the distal end of the support members;

extending the support members out of the tube member, wherein the distal ends of the support members are exposed;

locating the distal ends of the support members distally from a blood clot;

expanding the support members outwardly from the second wire to form a basket having proximal and distal ends thereof, wherein at least a portion of the second wire is disposed within the basket and radially between the support members; and

withdrawing the basket proximally to remove the blood clot.

9. The method of claim **8**, wherein the support members are made from a shape memory material, and the shape memory material expands the support members to form the basket.

10. The method of claim **8**, wherein the support members include a mesh portion at distal ends thereof, and the mesh portions form the basket in response to expanding the support members.

11. The method of claim **8** further comprising additionally expanding the support members to contact the vessel wall.

12. The method of claim **8** further comprising moving the second wire proximally relative to the first wire to expand the support members.

13. The method of claim **8** further comprising moving the first wire proximally to pull the proximal end of the basket toward the tube member.

14. The method of claim **8** further comprising moving the first wire and second wire together to maintain the shape of the basket member and adjust the longitudinal location of the basket.

15. A blood clot retrieval apparatus comprising:

a first support member having a proximal end and a distal end, the first arm member having a first mesh portion at the distal end thereof;

a second support member having a proximal end and a distal end, the second arm member having a second mesh portion at the distal end thereof;

a first wire extending proximally and attached to the proximal ends of the first and second support members;

a second wire extending proximally and attached to the distal ends of the first and second support members;

wherein the first and second support members are configured to adjust between a compressed condition and an expanded condition;

wherein the expanded condition defines a basket;

wherein the second wire extends within the basket; and

wherein the second wire is configured for adjusting the width of the basket.

16. The apparatus of claim **15**, wherein the distal ends of first and second support members are mounted within a distal housing.

17. The apparatus of claim **15** further comprising a wire guide coil attached at the distal ends of the first and second support members.

18. The apparatus of claim **15**, wherein the first and second wire are adjustable relative to each other to change the shape of the basket defined by the first and second support members.

19. The apparatus of claim **15**, wherein the first and second wire are adjustable together to maintain the shape of the basket defined by the first and second support members while translating the basket.

20. The apparatus of claim **15**, wherein the support members are made from a material having shape memory characteristics that define a shape of the basket absent actuation by the first or second wires.

* * * * *